PURDUE
UNIVERSITY

The Will to Win . . . — Victory Through Manpower

WAR TRAINING COURSES

IN

ENGINEERING SCIENCE MANAGEMENT

UNDER AUSPICES OF THE
UNITED STATES OFFICE OF EDUCATION

1942-43

For Further Information
Contact Your
Plant Personnel Office
Purdue's Local Representative
or Write
Purdue War Training Office
Lafayette, Indiana

WAR TRAINING COURSES in ENGINEERING, SCIENCE, MANAGEMENT

War Training Courses in Engineering, Science and Management, as offered by Purdue University in most of the industrial centers of Indiana, are designed to train men and women for technical and supervisory jobs in war production.

America faces today the gigantic task of training armies not only for the battle fronts of Democracy but also to man the assembly lines of production. Older men and women must take their places in the shops, factories, and drafting rooms of industry. In order to provide the training needed by qualified war workers, the United States Office of Education has authorized recognized engineering colleges to give tuition-free technical training in fields essential to the war effort.

Purdue University is offering a wide range of courses, some designed to prepare trainees for new fields of work, others to fit those already employed in war activities for more difficult and responsible assignments. They are contingent upon the demand for such training and subject to approval by the Office of Education. Additional courses will be offered where needed.

Although ESMWT courses are offered without restriction as to age, sex, race, or condition of employment, applicants must be employable at the kind of work to which the training is directed, and must meet the requirements of the course. These vary with the complexity of the subject and the purpose of the training, ranging from high school graduation only to engineering degrees.

Classes receive personal instruction from qualified teachers. No correspondence courses are offered. Although instruction is of college level, ESMWT courses are not a substitute for regular college courses leading to a degree. On the basis of attendance, daily grades, tests, and quarterly grades, Purdue will award certificates to trainees who satisfactorily complete a course.

Most of the classes meet two or three evenings a week, although day classes and full-time courses are available to meet specific needs. Starting dates vary by localities. The Federal Government pays the cost of tuition; trainees pay for text books, minor supplies, and their own living expenses. The average cost of texts and supplies is $5.00 per student.

The following is a partial list of courses being offered by Purdue during the current year. Additional information may be obtained from your plant personnel office, from Purdue's local representative, or by writing to the Purdue War Training Office, Lafayette, Indiana.

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(Note All courses are 12 weeks in length, two three-hour periods a week for a total of 72 hours, except as otherwise noted.)

COURSE DESCRIPTIONS

Course Number CHEMICAL ENGINEERING

102—Chemistry for Engineering Material Inspectors

Experience for admission: Two years of college chemistry, including general and organic, or Courses 908 (Engineering General Chemistry) and 906 (Engineering Organic Chemistry), or equivalent.

Purpose: To acquaint trainees with common engineering methods, properties and tests for inspecting and determining the quality of materials; to make them more proficient in testing materials; to train men in obtaining representative samples and in visual evaluation of materials.

Description: The trainee begins with a description of the tests required and the uses of the materials he is testing, followed by a brief outline of the method of sampling and testing, and finally an introduction to the method of setting up specifications for such methods.

104—Distillation in the Petroleum Industry

Experience for admission: College graduate or equivalent with at least two years of college chemistry, or Courses 908 (Engineering General Chemistry) and 906 (Engineering Organic Chemistry), or considerable experience in the field of petroleum refining.

Purpose: This course represents a comprehensive study of the fundamental theory for practice in distillation as applied to petroleum refining.

Description: A rapid review of fundamental physical-chemical laws brings the trainee up to date. This is followed by an introduction to the applications of distillation in petroleum refining with an explanation of the complexities encountered and the methods utilized to solve them.

105—Petroleum Refining

Experience for admission: College graduate or equivalent with at least one year of college chemistry, or Course 908 (Engineering General Chemistry), and some experience in the field of petroleum production.

Purpose: To give fundamental training in the problems and methods of petroleum refining for men connected with the industry or others who have some knowledge of the industry; to assist men already trained in the field to review and expand their knowledge; to bring men in operation up to date on late advances in the industry.

Description: The first few lectures review fundamental physical and chemical considerations of refinery processes, and principles of design, fundamentals of heat transfer, fluid flow, heat and material balance, etc. This is followed by a comprehensive and detailed study of problems encountered in refinery processes. The course offers an opportunity for a thorough understanding of petroleum refining as it is practiced in modern industry.

110—Metallurgical Analysis of Ferrous Metals

Experience for admission: High school chemistry or equivalent, or present employment in analytical chemistry work.

Purpose: To train beginners in methods and principles of chemical analysis used for control purposes in the iron and steel industry; to serve as a review for analytical chemists in the industry.

Description: A short review of elementary chemistry, with special emphasis on elements occurring in steel, is followed by a brief study of steel production to indicate sources of the elements to be analyzed and their importance. Most of the work is devoted to theory and methods used in the analysis of nine elements: carbon, manganese, phosphorous, sulfur, silicon, nickel, chromium, vanadium and molybdenum.

113—Chemical Engineering for Production Supervision

Experience for admission: High school chemistry or Course 908 (Engineering General Chemistry) and employment in and/or training for supervisory work in the field of chemical engineering.

Purpose: To train men in basic principles of chemical engineering operation, stressing applications to specific plant problems; to broaden the usefulness of plant supervisors by giving them the methods controlling operations under their supervision.

Description: The first few lectures cover a rapid review of fundamental principles of chemistry and physics, followed by a study of heating and material balance, transformation of energy, and other fundamental material essential to engineering calculations. Studies are made of various chemical engineering unit operations applicable to plant processes of interest to the group.

Additional Courses

Boiler Feed Water Conditioning (114)
Chemical Engineering for Unit Processing (117)
Chemistry of Paint (107)
Chemistry of Paper and Pulp (103)
Chemistry of Powder and Explosives (101)
Chemistry of Rubber (109)
Control Instruments for Chemical Industries (112)
Distillation and Fractionation of Industrial Alcohol (115)
Dryer and Evaporation Processes (116)
Organic Chemistry of Plastics (106)
Plastics in Construction (111)

CIVIL ENGINEERING

201—Elementary Structural Drafting

Experience for admission: Previous training in engineering, mechanical, or architectural drawing, or Courses 404 (Fundamentals of Engineering Drawing) or 401 (Engineering Drawing) or one year of engineering college training, or equivalent industrial experience.

Purpose: To develop greater ability in subordinate workers in occupations dealing with supply, fabrication or erection of materials for construction, by developing: (a) increased ability to make shop drawings for production purposes, (b) greater ease in reading drawings for erection of structures.

Description: The course includes a brief review of the techniques of lettering and pencil drawing followed by discussions and exercises in detailing simple structural steel members and structures, simplified reinforced concrete construction, and a simple wood cross with modern connectors.

209—Modern Field Problems in Highway and Airport Engineering

Experience for admission: Two years of civil engineering college work, or four years of highway or airport structure experience.

Purpose: To review some fundamentals of highway and airport engineering; to present the latest developments in highway and airport engineering; to study highway technical problems peculiar to Indiana.

Description: In the first portion some fundamentals of airport and highway engineering are given, including basic data on the relationship of bedrock geology, glacial drift geology, and soils to the performance of pavements. The second portion is devoted to materials, sampling and testing, and research. The third portion deals with pavement slabs, including low-cost, portland cement concrete, and bituminous surfaces.

Additional Courses

Elementary Structures (203)
Indeterminate Structures (207)
Materials Testing (208)
Reinforced Concrete Foundations (205)
Sewage Disposal Systems—Design (215)
Sewage Treatment—Operation (213)
Sewage Treatment—Theory and Design (212)
Soil Mechanics—Applied to Foundation Engineering (210)
Stress Analysis and Design of Elementary Structures (211)
Stresses (202)
Structural Design (206)
Theory of Structures (204)
Topographic Mapping Procedures (216)
Water Supply—Design, Treatment and Distribution Systems (214)

ELECTRICAL ENGINEERING

301—Direct-Current Circuits and Machinery

Experience for admission: High school or college physics, or Course 902 (Engineering Physics), and a knowledge of algebra and trigonometry or Courses 913 (Mathematics for Electrical Engineers) or 914 (Engineering Mathematics), or equivalent.

Purpose: To train assistants to graduate electrical engineers; to train for electrical experimental, testing, and production work; to assist in upgrading those who are already doing electrical work.

Description: The course familiarizes students with basic principles of electrical engineering and trains them in the application of these principles to common direct-current circuits and devices. Emphasis is placed on the use of these principles in various kinds of technical situations rather than on the characteristics of specific pieces of apparatus. Starting with the simplest concepts of electric current and its nature and terminology, the principles are applied progressively to a series-circuit, parallel-circuit, series-parallel-circuit, three-wire circuit, and simple network. The rudiments of magnetic circuits are then correlated with those of electric circuits. Finally, the principles of both electric and magnetic circuits are applied to various kinds of direct-current generators and motors.

302—Alternating-Current Circuits and Machinery

Experience for admission: High school or college physics, or Course 902 (Engineering Physics), and a knowledge of algebra and trigonometry, or Courses 913 (Mathematics for Electrical Engineers) or 914 (Engineering Mathematics), and a knowledge of direct current circuits, or Course 301 (Direct Current Circuits and Machinery), or its equivalent.

Purpose: To train assistants to graduate electrical engineers; to train for experimental, testing, and production electrical work; to assist in the upgrading of those who are already doing electrical work.

Description: This course assumes that the trainee is familiar with basic principles of direct-current circuits and magnetic circuits and continues with the application of these principles to circuits and devices carrying alternating current. Emphasis is placed on the application of these principles. Fundamental definitions, the nature of alternating currents, especially those which are sinusoidal, and the use of vectors for making calculations are studied. The principles are then applied progressively to series-circuits, parallel-circuits, series-parallel circuits, three-wire circuits, and polyphase circuits. These methods of analysis are then applied to transformers, induction motors, alternating-current generators, synchronous motors, and converters. There is also included an introduction to the problems of lighting and electronics.

303—Industrial Electronics I

Experience for admission: Thorough knowledge of algebra, trigonometry, and direct-current and alternating-current principles, or Courses 913 (Mathematics for Electrical Engineers) or 914 (Engineering Mathematics), and 301 and 302 (Direct Current and Alternating Current Circuits and Machinery), or equivalent.

Purpose: To provide instruction in the fundamentals and applications of engineering electronics for men engaged in war production. By an application of electronic devices to industrial processes, materials can be produced more effectively.

Description: This is an elementary course for those who have already acquired an understanding of the fundamental principles of electricity. Topics such as laws of thermionic emission, control of free electrons, ionization, etc., are discussed. The principal characteristics of electronic tubes ranging from diodes to pentodes and from pool-type rectifiers to television iconoscopes are presented and studied.

306—Power Generation

Experience for admission: Knowledge of direct- and alternating-current circuits and machinery (Courses 301 and 302) or equivalent.

Purpose: To give the trainee practical knowledge of problems with which the electrical engineer deals in the design and operation of a power plant; to aid in training men as operators and helpers in power plants; to assist present power plant operators in preparing for positions of greater responsibility.

Description: This course includes the economics and engineering consideration pertaining to the location and design of electric power plants, electric generat-

ing equipment, plant layout, switch gear and switching, station operation and protection.

308—Radio Engineering

Experience for admission: A knowledge of industrial electronics (Courses 303 and 304), and/or the equivalent college training or industrial experience.

Purpose: To familiarize the trainee with radio vacuum tube circuits; to develop an understanding of electrical engineering principles as applied in radio; to instruct in the design, operation, and servicing of modern receiving equipment.

Description: The first few lessons review alternating-current theory, properties of coils and condensers, complex notation, etc. After a brief review of vacuum tube fundamentals, various types of amplifiers and conventional coupling methods are studied. Several lessons are devoted to radio transmitter design including both code and audio transmitters. Radio receivers are covered thoroughly and demonstration sets explained. The last few lessons cover antenna, wave propagation theory, and such applications as radio aids to navigation.

311—Power Transmission and Distribution

Experience for admission: Graduation in electrical engineering or considerable experience in electrical work including a working knowledge of algebra and trigonometry.

Purpose: Training in engineering techniques used by transmission and distribution engineers; acquirement of information and factual data needed in connection with the engineering, construction, and operation of transmitting and distribution circuits.

Description: This course deals with the basic theory underlying transmission and distribution line calculations and with the materials from which line structures are built. Poles, conductor materials, types of conductors, line insulators, and other materials are studied and discussed.

316—Fundamentals of Electrical and Radio Engineering

Experience for admission: High school physics, or Courses 902 (Engineering Physics) or 913 (Mathematics for Electrical Engineers), or equivalent industrial experience.

Purpose: To serve as an introduction to electrical engineering, electronics and radio engineering; to teach basic principles of electrical and radio engineering; to create new and better workmen in the communication industry.

Description: This course is designed primarily for persons with limited knowledge of electronics and radio who are employed or seek employment in electrical or communication industries. The subject matter is chosen and arranged in such a manner that any one possessing the necessary prerequisites may be able to complete the course without difficulty. The first half deals with the fundamentals of electrical engineering and the latter half with the principles of radio. All the topics included in the outline cannot be covered in detail but will be discussed in an elementary way. This course should provide sufficient background to assist those who are employed in such positions as

circuit analysts, "trouble shooters," or other jobs of similar character.

320—FUNDAMENTALS OF RADIO I

Length of course: 16 weeks, 3 three-hour periods per week—total 144 hours.

Experience for admission: High school graduation, including two years of mathematics and one year of physics.

Purpose: To impart basic radio knowledge to laymen and those employed in the field; to give preliminary training to men who will become radio technicians in the armed forces of the United States; to train personnel (men and women) for civilian radio positions vacated by those entering armed service.

Description: This is a basic course in fundamental principles of radio, beginning with a review of simple mathematics applicable to electricity and radio, followed by a study of the fundamentals of electricity. The course covers basic fundamentals of electronics, characteristics of vacuum tubes and application of electron tubes in circuits. A study of circuits including rectifiers, audio-frequency amplifiers, oscillators, cathode-ray oscilloscopes, simple telephones, etc., is made and experiments are performed by trainees on various types of apparatus. The course contains 15 experiments covering the major subjects of electricity and elementary radio circuits. These are student-participation experiments which greatly aid in a thorough understanding of the course material.

321—FUNDAMENTALS OF RADIO II

Length of course: 16 weeks, 3 three-hour periods per week—total 144 hours.

Experience for admission: Course 320 (Fundamentals of Radio I); high school graduation including two years of mathematics and one year of physics.

Purpose: To impart basic radio knowledge to laymen and those employed in the field; to give training to men who will become technicians in the armed forces; to train personnel for civilian radio positions.

Description: Instruction is provided in fundamentals of radio communication including both transmission and reception. A study is made of the characteristics and operation of radio receivers with special emphasis placed on superheterodyne and frequency-modulated receivers. Component parts of transmitters including oscillators, amplifiers and modulators are discussed in detail. Both amplitude and frequency modulation methods are considered. Also included is a study of radio wave propagation, transmission lines, antennas and direction finding. Emphasis is placed on practical application as well as theoretical principles.

322—PRINCIPLES OF INDUSTRIAL RADIO ENGINEERING

Experience for admission: The trainee must have a knowledge of the basic principles of electronics and radio engineering, or Courses 316 (Fundamentals of Electrical and Radio Engineering) or 320 (Fundamentals of Radio I), or equivalent.

Purpose: To serve as a course in which the design equations of radio receivers are studied; to aid persons in radio manufacturing plants to be more efficient through an understanding of the product of the plant; to qualify certain persons as engineer aides.

Description: This course gives an opportunity for study of design equations and principles used in the actual design of radio equipment. Emphasis is placed on the use and interpretation of those formulae and accepted precepts of radio design. Learning how to apply formulae properly is more important at times than to know the derivation of formulae; the former is the aim of this course.

Additional Courses

Analysis and Design of Electronic Circuits (305)
Electrical Design I (307)
Electrical Design II (310)
Electrical Measurements (309)
Fundamentals of Symmetrical Components (312)
Industrial Electronics II (304)
National Safety Code for Power Distribution (317)
Radio Engineering II (319)
Symmetrical Components—Motor Performance (313)
Symmetrical Components—Power Protection (314)
Ultra High Frequency Techniques (Campus Only) (315)

ENGINEERING PRACTICES

401—Engineering Drawing

Experience for admission: Knowledge of the fundamental concepts of engineering drawing, or Course 404, or equivalent experience in industrial drafting.

Purpose: To develop greater efficiency and proficiency among workers in war industries by developing: (a) higher skills and ability to do production detailing and designing, (b) greater facility in reading drawings because of an increased knowledge of the accepted symbols and representations used in industrial plans and specifications; to assist in upgrading draftsmen specifically, and workmen generally, by helping to pick out those who have natural abilities or developed skills in this field.

Description: The first portion of the course includes some elementary work to serve as a basis for a review of drafting fundamentals. This is followed by problems in advanced drawings, or details and assemblies. Finally, the trainee is encouraged to attempt some actual designing in line with his past experience and ability. This specialized work will be coordinated with particular needs in specialized industries.

402—Applied Mechanics: Statics

Experience for admission: The applicant must have a working knowledge of algebra, trigonometry and elementary physics, or Courses 914 (Engineering Mathematics) and 902 (Engineering Physics), or equivalent.

Purpose: To familiarize trainees with the development and application of formulae and methods for determining force relations between and reciprocal effects of members of jointed structures or machines; to show how to determine the value of forces acting on the whole or part of any structure. The course deals primarily with relations of forces and distances in equilibrium. This course, along with Courses 407 (Kinetics) and 403 (Strength of Materials), provides a background for engineering structures and design, etc.

Description: The course includes resolution and composition of forces; moments; equilibrium and its application to jointed frames, trusses, machines, etc.; friction; center of gravity.

403—Strength of Materials

Experience for admission: Must be preceded by a knowledge of statics and kinetics, or Courses 402 (Applied Mechanics: Statics) and preceded or accompanied by 407 (Applied Mechanics: Kinetics), or equivalent.

Purpose: This course deals primarily with relations between external actions or forces and internal effects. It gives the trainee an understanding of the reasons for particular forms in structures, machines, etc., and furnishes him with a very effective tool or foundation for engineering design.

Description: The course content includes such subjects as stresses in and deformations of common engineering materials in tension, compression and shear: pipes and boiler shells; shafting; helical springs; beam stresses and deflections; combined stresses; columns.

404—Fundamentals of Engineering Drawing

Experience for admission: High school graduation. Trainees with one or more years of machine shop experience in industry are preferred; however, the training is open to others with such interest and ability.

Purpose: To train men and women as draftsmen for positions in war industry by: (a) broadening their knowledge of engineering fundamentals, (b) developing their manipulative and technical ability with drafting equipment.

Description: This course is designed to give men and women an opportunity to develop the fundamental industrial techniques of drafting. Emphasis is placed upon ability to visualize while developing habits and skills necessary to make accurate and complete detailed drawings. Instruction includes: the use of instruments, lettering, orthographic projection, auxiliary views, sectional views, sketching and pictorial drawing, screw threads and fasteners, and dimensioning of detail and assembly drawings.

405—Industrial Instruments for Measurements and Control

Experience for admission: High school physics, or Course 902 (Engineering Physics) or its equivalent in college, or industrial experience.

Purpose: To develop greater efficiency and proficiency among workers in war industries by developing: (a) ability to choose the proper instruments for making a desired measurement, (b) ability to superintend the correct installation of the instruments, (c) an understanding of the limitations of the instruments, (d) ability to operate the instruments successfully, (e) ability to maintain the instruments properly, (f) ability to use the information obtained from the instruments to effect an economic operation of production equipment.

Description: The course consists of a study of the basic principles of measurement: measurement of length, area, form, force, pressure, density, specific gravity, time velocity, acceleration, torque, work, power, liquid and gas flow, heat quantities, temperature, and electrical quantities, including current, voltage and resistance; magnetic quantities; light and sound. Electronic methods and the application of graphic instruments to plant operation analysis are fully covered.

Additional Courses

Applied Descriptive Geometry (410)
Applied Mechanics—Kinetics (407)
Industrial Practices and Specifications (408)

MANAGEMENT

504—Cost Control for Engineers

Experience for admission: High school education, including one year of bookkeeping or accounting; factory supervisory experience is desirable.

Purpose: To impart a knowledge of cost methods, procedures and possibilities for control, enabling trainees to contribute to more efficient and economical production, distribution and control of goods; to train and upgrade the following specific employee groups: stock supervisors, in methods and theories of control accounting for materials and supplies; payroll supervisors, in the accumulation and distribution of labor costs and in payroll accounting and labor wage theory; cost supervisors, in methods and theories of accumulating and distributing factory burden costs; cost accountants, in an over-all appreciation of the workings of various cost accounting systems (including standard costs) for production control; engineers, in an understanding of accounting principles involved in cost determination and control, and of the ways in which the work of accountants and engineers necessitates cooperation.

Description: A study of theories and techniques of accounting for materials, labor, and factory burden costs under specific order and process cost systems, plus a consideration of standard costs, estimating costs, distribution costs, and cost accounting as a means of measuring efficiency and controlling production costs.

505—Management Essentials

Experience for admission: High school graduation, or equivalent industrial experience. No factory experience is necessary although it would be a helpful asset.

Purpose: This training is provided for individuals with leadership ability who wish to broaden their knowledge of management essentials in order to increase their capacity for assuming responsibility as foremen or supervisors in modern industrial organization. In addition, this course is helpful in determining the responsibility and authority of those who are already in supervisory positions. It is especially designed for those persons who have held supervisory positions within the non-essential industries and who are now considering transferring to the war production industries.

Description: The development of modern industrial organization is summarized, followed by a detailed discussion of departmental functions, the duties of management, planning, quality control, financial controls, personnel problems, upgrading, safety, wages and policies. Classes are taught by the conference method.

506—Production Methods

Experience for admission: Graduation from high school, or equivalent industrial experience. Note: Those with college education or greater industrial qualifications should take Course 603 (Motion and Time Study).

Purpose: This course teaches production methods to men in supervisory positions in industry; furthermore, the course is designed to promote a "motion consciousness" on the part of the supervisor.

Description: The teaching of "movement" or "motion consciousness" is intended to aid supervisors in meeting the production requirements of modern industry. The course includes: production difficulties and solutions, operation analysis, movement analysis, production improvement through job improvement and work simplification, and instruction methods. The classes are taught by the conference method. Trainees are expected to enter freely into all discussions, presenting, if possible, that part of their experience which would tend to increase the general knowledge of the subject at hand.

Additional Courses

Advanced Industrial Statistics for Control (510)
Elements of Industrial Engineering (507)
Fundamentals of Industrial Statistics for Control (509)
Industrial Analysis and Technical Reports (508)

MANUFACTURING PROCESSES

601—Jig and Fixture Design

Experience for admission: High school graduation; at least one year of active machine shop experience; at least two years or more of industrial drafting experience or one year of university engineering study including engineering drawing and shop experience.

Purpose: To give mechanical draftsmen who are qualified to handle elementary tool design an opportunity to study the theory of design, and to design jigs and fixtures for modern production methods.

Description: This is a laboratory course with emphasis on actual design of jigs and fixtures for the production of interchangeable parts. Position theory is introduced in designing for practical industrial production. It gives the tool engineer an understanding of the analytical planning of tool devices used in the manufacture of duplicate parts of machines to make possible interchangeable work at a reduced cost.

602—Die Design

Experience for admission: High school graduation; machine shop experience; two years or more of drafting experience or one year of university engineering study including engineering drawing.

Purpose: To develop the ability of mechanical draftsmen for elementary tool design by (a) a careful study of the theory of die design, (b) the actual designing, under supervision, of sheet metal dies.

Description: This is strictly a design course with the main emphasis on dies for sheet metal work. Sufficient theory is introduced to give a fundamental idea of design problems involved. In all cases, practical industrial problems are used for discussion and solution.

603—Motion and Time Study

Experience for admission: Two years of engineering college training, or equivalent industrial experience.

Purpose: To train individuals in the effective use of techniques of motion and time study which will increase the productivity of industrial, service, and agri-

cultural activities, including: modern methods of analyzing processes, operations, materials and equipment to find the most economical way of doing the work; standardizing tools, equipment and material; use of stop watches to determine the time required to do the job; best methods of training workers; proper approach to the human relations problems involved.

Description: An introduction to the techniques of motion and time study and their interrelationships is followed by a detailed discussion of process charts, operation charts, micromotion study, therblig check lists, motion economy, and stop watch time study, including not only technical details but also methods of application and personnel problems. The methods are applied to typical problems from the trainee's industry.

604—Production Engineering I

Experience for admission: High school graduation and manufacturing experience as a supervisor of production.

Purpose: To offer training in the solution of production problems through a study of modern methods and processes of industry enabling trainees to increase war production.

Description: The course is intended to give persons who are in a supervisory capacity an adequate background in production planning and control, including a study of production design, part analysis, plant layout, and materials handling. Students will be encouraged to bring in for practical solution any problems that they may have encountered in factory cost analysis and control.

605—Industrial Safety Engineering

Experience for admission: High school graduation and at least two years of industrial experience, preferably in the field of industrial safety, supervision or personnel work.

Purpose: To promote safety in every plant; to train men in safe working habits; and to teach men to train other personnel in safe ways of work.

Description: This course is intended to promote the cause of safety in industry and train men in safe working habits, thereby permitting them to give this information to other workers in their plants. The course includes: the history of the safety movement, economics of accident prevention, the making and keeping of accident records and their use in accident prevention, mechanical safeguards, fire prevention, occupational disease, hygiene and first aid.

606—Gauge Design

Experience for admission: Two years of industrial machine drafting experience or equivalent.

Purpose: To provide training in the art of gauge design, gauge making, and gauge use.

Description: This course gives draftsmen training in the design of gauges and measuring instruments, and provides some design training for tool makers, tool operators and designers. Furthermore, the course gives an adequate background in the history and application of measurement in interchangeable manufacture.

607—Advanced Motion and Time Study

Experience for admission: Experience as an industrial engineer in charge of motion and time study work,

and/or equivalent college training or Course 603 (Motion and Time Study).

Purpose: Provides basic information and practice in the use of advanced techniques in motion and time study for persons having preliminary training, and equips them to make efficient use of industrial manpower.

Description: The course includes the formulation of industrial policies for motion and time study. Practice in stop-watch time study and in the construction of standard time and synthetic rates is given adequate coverage. There is also an opportunity to obtain practice with micromotion study and motion analysis. Methods of selecting efficient ways of doing work prior to actual production are considered.

611—Precision Measurements in the Machine Industry

Experience for admission: High school graduation and experience as an inspector or instrument checker preferred, or experience as a tool maker.

Purpose: To study measurements and measuring instruments and their use in modern production.

Description: This course offers a detailed study of all types of measurement and measuring instruments from the common rule to measurement by light waves. The history of measurement standards from early days to the present is considered. Methods, machines and instruments are fully discussed. The course is valuable for instrument inspectors and checkers, and persons responsible for accurate measurement of machine parts in interchangeable manufacture.

613—Engineering Materials and Processes

Experience for admission: High school graduation and employment in a war industry or considering such employment.

Purpose: To provide factual information about materials and processes used in industry; to better equip the trainee for industrial work.

Description: This course is designed to give new industrial workers (especially women) a technical background in industrial materials and processes applied to the machine industry. Course content includes: the manufacture and properties of iron and steel and non-ferrous metals; plastics and plastic molding; hot and cold working of metals; joining of metals; machine shop methods; machine tools; gears and gear cutting machines; grinding and other surface-finishing processes.

614—Production Engineering II

Experience for admission: High school graduation and responsible production experience in a supervisory capacity.

Purpose: To give such training as may be best suited to increase the efficiency of those who are supervising the production of essential war materials.

Description: This course is designed to offer practical training to industrial staff supervisors. This training is to be provided through a study of management, organization, personnel and other related problems. Materials covered are: industrial organization and function, managerial policies, morale building, personnel functions, employers' service activities, wage and salary standardization and incentives, merit

rating, quality control, industrial safety, time study and factory costs.

616—Production Control

Experience for admission: Two years of engineering college study, or equivalent industrial training and experience.

Purpose: To provide training in those basic elements of industrial control essential to modern mass production.

Description: This course covers all phases of production control. It takes the product from its inception, through design planning, procurement, routing, scheduling, dispatching, production, to the shipping room. A discussion of factory production cost is also included.

617—Advanced Industrial Safety Engineering

Experience for admission: High school graduation and industrial experience. Several years in the field of industrial safety, supervision or personnel management are requested as this is strictly an engineering quality course.

Purpose: To promote safety engineering in every industrial plant; to assist students already familiar with safety work in obtaining a better knowledge of the principles and techniques of safety engineering; to train supervisory personnel in the engineering control procedures necessary for teaching others safe ways of work.

Description: This course is intended to teach control techniques, psychology, and philosophy of modern accident prevention. Stress is laid on accident causes and corrective action necessary in preventing accidents due to such causes. Accident investigation and safety inspection are studied as well as safety codes, national, municipal and local; fire prevention; first aid; industrial health hazards; and workmen's compensation and occupational disease laws.

Additional Courses

Design for Welding (612)
Foundry Operation and Control (608)
Fundamentals of Grinding Theory (610)
Hydraulic Pressure Circuits (609)
Ordnance Inspection (In-service Course) (615)

MECHANICAL ENGINEERING

701—Elementary Heat Engineering for Internal Combustion Engines

Experience for admission: Knowledge of algebra, trigonometry and the fundamental concepts of engineering physics and calculus, and/or Courses 914 (Engineering Mathematics), 902 (Engineering Physics) and 909 (Mathematical Analysis for Engineers), or equivalent experience.

Purpose: To train men in the general principles of internal combustion engine operation and maintenance and thereby prepare them for more responsible positions in their field; to study elementary principles and theory of internal combustion engines so as to furnish workers in war industries with a better understanding of such equipment, enabling them to more intelligently operate it with greater output and less operating trouble.

Description: This course covers a general discussion of internal combustion engine types and designs. The elementary principles of combustion and thermodynamics is followed by a study of internal combustion engine cycles and of factors influencing engine performance. Because of the limited time only elementary fundamentals are covered.

702—Elementary Heat Engineering for Steam Power Plants

Experience for admission: Knowledge of algebra, trigonometry and fundamental concepts of calculus and engineering physics, or Courses 902 (Engineering Physics), 914 (Engineering Mathematics) and 909 (Mathematical Analysis for Engineers), or equivalent industrial experience.

Purpose: To cover elementary theory and operation principles of power plant equipment so that workers in war industries will better understand the functions of such equipment. This will result in more efficient and intelligent operation and, in turn, greater output and less operating trouble. To train men interested in power plant work for more responsible positions in the field.

Description: This course covers a general survey of steam power plant equipment and elementary thermodynamic principles which govern its operation. Because of the wide range of equipment involved and the limited time available only a general survey is possible covering principal types of equipment and the elementary theory which applies to them.

703—Mechanism

Experience for admission: Knowledge of algebra, trigonometry, and fundamental concepts of calculus, engineering physics and drawing, or Courses 914 (Engineering Mathematics) or 910 (Mathematics Applied to the Machine Industry), 902 (Engineering Physics), 909 (Mathematical Analysis for Engineers) and 401 (Engineering Drawing), or equivalent industrial experience.

Purpose: To acquaint the trainee with the mechanics of common machine parts; to present principles of mechanisms to aid in the design, selection and operation of machines.

Description: An orderly study is made of the various types of mechanical movements common to machines and to combinations thereof. Analysis is made of displacements and velocities of machine parts to aid the development of methods for predicting the performance of these parts. Knowledge of the principles of mechanism is essential to elementary machine design.

704—Machine Design

Experience for admission: Knowledge of applied mechanics: statics and kinetics, and strength of materials, or Courses 402 (Applied Mechanics: Statics), 403 (Strength of Materials) and 407 (Applied Mechanics: Kinetics), or their equivalent; experience with machines and some knowledge of their operation.

Purpose: To develop ability to make calculations for machine design; to acquaint workers with successful design procedure; to prepare for the analysis that accompanies machine design; to develop ability to improve the design of existing machines and thereby increase production.

Description: The course emphasizes factors in the design and selection of machines and machine parts. Selection of material, safety factors and limiting operation conditions are followed by procedures necessary for determining the proportion of various parts. The necessity for evaluating assumptions is explained and demonstrated. Constant examples show the use of standards and the influence of manufacturing methods and of cost.

707—Lubrication Fundamentals

Experience for admission: Knowledge of applied mechanics: statics and kinetics, and engineering physics, or Courses 902 (Engineering Physics), 402 (Applied Mechanics: Statics) and 407 (Applied Mechanics: Kinetics), or their equivalent, including one year of machine operation and of industrial drafting.

Purpose: To give practical training in lubrication fundamentals; to give detailed information about properties and selection of lubricants, methods employed in lubricating common machines, and methods for improving lubrication conditions; to build up each trainee's knowledge of the action in a lubricated bearing so that he will be able to meet, with some confidence, a wide variety of problems involving design, operation, and purchase of lubricating systems.

Description: The properties of all greases, including viscosity, are given first, followed by treatment of film formation in bearings, where the relations between friction and other factors are brought out. The rest of the course covers oiling devices and systems, and the lubrication of steam turbines, gear units, air compressors, refrigerators, engines and other machines of interest to the group.

713—Gear Fundamentals and Practical Problems

Experience for admission: Knowledge of engineering drawing, applied mechanics: statics and kinetics, strength of materials and mechanism, or Courses 402 (Applied Mechanics: Statics), 403 (Strength of Materials), 404 (Engineering Drawing), 407 (Applied Mechanics: Kinetics) and 703 (Mechanism), or experience in design, manufacture, and inspection of gears plus a working knowledge of trigonometry.

Purpose: To furnish knowledge for those working with the design, manufacture, inspection and application of gears; to present basic features of gear tooth design and the application of these principles; to indicate the desired building and design of special gears for specific conditions.

Description: The relationship of rolling curves, properties of gear tooth forms, characteristics of gear tooth action, and modifications of theoretical tooth forms are demonstrated and studied. Special tooth forms are analyzed. Strength and surface durability calculations are demonstrated and the factors influencing pitch selections are discussed. Gear generating processes are covered briefly. Spur, helical, internal, bevel and worm gears are described and discussed fully.

723—Introduction to Aircraft Engines

Experience for admission: The student should have a background in algebra, trigonometry and physics, or Courses 914 (Engineering Mathematics) and 902 (Engineering Physics) or equivalent, and a practical knowledge of internal combustion engines.

Purpose: To familiarize men and women employed, or those who expect to be employed, in industry making aircraft engines or parts thereof, with the details of the aircraft engine, accessory construction, and operation.

Description: The course includes a description of various types of aircraft engines and auxiliaries, and an analysis of the functioning of various component parts. Consideration is given to efficient operation and maintenance of the aircraft engine.

724—Introduction to Aerodynamics

Experience for admission: The student should have a background in algebra, trigonometry and physics, or Courses 914 (Engineering Mathematics) and 902 (Engineering Physics), or equivalent.

Purpose: This course is intended to give the worker in aircraft industry an understanding of elementary aerodynamics applied to the airplane.

Description: The theory of elementary aerodynamics is presented in such a manner that a trainee with a limited background of mathematics and physics can obtain the fundamentals. A survey of the critical factors affecting stable and efficient flight are considered.

Additional Courses

Aerodynamics of Airplane Design (708)
Aeronautical Drafting (722)
Aircraft Drafting and Inspection Procedures (728)
Aircraft Engine Design (711)
Aircraft Engines (710)
Applied Theory of Measurement for Ship Construction (733)
Combustion Engineering (718)
Diesel Engineering (716)
Elementary Heating and Ventilation (712)
Fluid Mechanics (725)
Introduction to Combustion Engine Design (706)
Introduction to Combustion Engines (705)
Machine Drawing (721)
Marine Drafting for Loftsmen (732)
Mechanical Vibrations (717)
Power Plant Testing (720)
Principles and Practices of Aircraft Construction Part I (726)
Principles and Practices of Aircraft Construction Part II (727)
Principles and Practices of Ship Construction (729)
Principles of Ship Erections (731)
Principles of Ship Fitting (730)
Special Gear Problem (714)
Steam Power Plant Equipment (719)
Structural Design of Airplane (722)
Theory and Practice of Diesel Engine Operation (Naval Engineering) (715)

METALLURGY

801—Elementary Metallurgy

Experience for admission: Applicants with high school chemistry, or Course 908 (Engineering General Chemistry) or its equivalent, plus industrial experience are preferred.

Purpose: To introduce fundamental concepts of metallurgy which may serve also as a foundation for more detailed study in specialized branches; to increase the worker's understanding of, and appreciation for, the many procedures of metal fabrication.

Description: This introductory course carries the trainee rapidly through production and physical metallurgy of both ferrous and non-ferrous metals and alloys. Production metallurgy deals with the refining of metals from their ores. Production of pig iron, copper, zinc, lead, aluminum and magnesium are included. Physical metallurgy deals with adapting refined metals to the use of man. This part of the course includes physical testing, microscopic study of metallic structures, and general characteristics and applications of the more important alloy systems.

802—Elementary Physical Metallurgy

Experience for admission: Applicants must possess a background in chemistry, physics, and elementary production metallurgy, and/or Courses 804 (Production Metallurgy) or 801 (Elementary Metallurgy), 902 (Engineering Physics) and 908 (Engineering General Chemistry), or equivalent industrial experience.

Purpose: To develop a better understanding of physical and chemical principles underlying changes in metals and alloys and to increase the efficiency and proficiency of war workers in mechanical treatment, thermal treatment, and utilization of metals and alloys.

Description: A study of the internal structure of metals and methods commonly employed in their examination, with special emphasis on the microscope, is followed by a study of constitutional diagrams, their interpretation and uses. Finally, the changes in internal structure are correlated with constitutional diagrams, mechanical and physical properties, and various treatments commonly employed in metallurgical operations.

803—Inspection of Metals

Experience for admission: Applicants must have an understanding of chemistry, physics, and elementary physical metallurgy, or Courses 802 (Elementary Physical Metallurgy), 902 (Engineering Physics) and 908 (Engineering General Chemistry), or equivalent.

Purpose: This course is designed to familiarize the student with various phases of the inspection of metals.

Description: Considerable time is devoted to steel mill inspection giving typical inspection problems. Subsequent metal working and treating as carried out in numerous fabricating plants calls for further gauging and inspection. Part of the course covers this phase of inspection. The latter portion of the course deals with physical testing as a tool in the inspection of metals.

804—Elementary Production Metallurgy

Experience for admission: One year of high school chemistry, or Course 908 (Engineering General Chemistry), or its equivalent, plus industrial experience.

Purpose: To provide a general survey of production metallurgy including raw materials, fundamental operations, equipment, chemical principles and applications; to provide a background for a subsequent study of more specialized work, such as inspection of metals,

ferrous metallurgy, non-ferrous metallurgy, etc., and to provide an understanding of the basic principles of metallurgical operation.

Description: This course includes the study of raw materials, ores, fluxes and fuels, materials handling, combustion, refractories, furnaces, roasting, sintering, smelting, production of iron and steel, production of copper, lead, gold, zinc, cadmium, aluminum, magnesium, silver, and fabrication of ferrous and non-ferrous materials.

805—Industrial Ferrous Alloys

Experience for admission: An understanding of basic principles of physical metallurgy, or Course 802 (Elementary Physical Metallurgy), or actual industrial experience.

Purpose: To increase workers' proficiency in war industries by developing: (a) higher skills and abilities in the thermal and mechanical treatment of steel; (b) greater facility in the utilization of steels through better knowledge of their properties and the effect of thermal and mechanical treatment; and (c) a more economical use of alloying elements in steels through a better knowledge of effects produced and response to heat treatment.

Description: The first part of the course presents the iron-carbon diagram and a study of related heat-treating principles, followed by a consideration of alloying elements generally added to steels and their effect upon response to heat treatment and upon properties. The latter part of the course deals with commercial heat treating operations as applied to commercial alloys.

806—Industrial Non-Ferrous Alloys

Experience for admission: An understanding of basic principles of physical metallurgy, or Course 802 (Elementary Physical Metallurgy) or industrial experience.

Purpose: To acquaint the trainee with properties and applications of important non-ferrous alloys with particular emphasis on those materials vital to war production.

Description: Common non-ferrous alloys are discussed and classified into four important groups according to the nature of their base metal, namely: (1) light-base metals and their alloys (the alloys of aluminum and magnesium), (2) copper-base alloys (brasses and the various bronzes), (3) nickel-base alloys (monel metal, inconel, and others), and (4) white metals and their alloys (alloys of lead, tin, zinc, and cadmium in particular). Many important bearing metals fall in this class. A few alloys not included in any of these groups are discussed separately. Powder metallurgy, an important metallurgical tool of particular interest in the non-ferrous field, is also discussed in this course.

807—Metallurgy of Welding

Experience for admission: An understanding of the basic principles of chemistry and elementary physical metallurgy, or Courses 908 (Engineering General Chemistry) and 802 (Elementary Physical Metallurgy), or industrial experience.

Purpose: To familiarize individuals working in the field with the composition and structure of steel, the effects of heat and stress in welding steel, and to show how metallurgical knowledge can be applied to control of the process.

Description: The subject material includes: manufacture of iron and steel, iron iron-carbide phase diagram, welding difficulties, effects of methods used in making difficult welds, slags, fluxes, electrodes and electrode coatings, residual stresses, stress relief, preheating, brittleness, welding of carbon, alloy and stainless steels, pressure welding, and special topics of interest to the group.

819—Foundry Metallurgy

Experience for admission: The student must have an understanding of foundry practice and elementary production metallurgy, or Courses 801 (Elementary Metallurgy) or 804 (Elementary Production Metallurgy), or equivalent industrial experience.

Purpose: This course is intended to acquaint foundry men with metallurgical aspects of the control and operation of the cast iron foundry.

Description: Emphasis is placed on factors influencing the production of castings and the engineering properties of cast iron.

824—Metallurgy of Iron and Steel

Experience for admission: High school graduation, and/or equivalent industrial experience.

Purpose: To furnish a comprehensive survey of the iron and steel industry from raw material to finished product; to train individuals so that they may understand the fundamentals of each step in making, shaping and treating steel; to discuss equipment used in steel plants so that trainees will obtain a general understanding of its function; to emphasize the importance of quality control and standard practices. In war time, lower grades of raw materials and substitutes for strategic metals necessitate changes in standard practice and quality control; trainees completing this course should be capable of going into any steel plant and in a relatively short time be able to aid effectively in the operation of plant equipment. This outline covers many details of equipment and operation not found in college texts and should be of special value to men who are, or expect to be, steel operators.

Description: The material to be covered includes: iron ores, fuels, blast-furnaces, basic and acid open-hearth, acid and basic Bessemer, crucible, cupola, electric furnaces, and detailed discussions of the practical operations of each step in the manufacture of iron and steel. Charts, graphs and diagrams are used for illustration.

Additional Courses

Blast Furnace Metallurgy (817)
Coke Oven Engineering Practice (825)
Corrosion of Metals (820)
Electro-Metallurgy (808)
Metallurgy of Aluminum (822)
Metallurgy of Flat Rolled Products (812)
Metallographic Laboratory Practice (811)
Metallurgy of Machine Operation (818)
Metallurgy of Magnesium (823)

Metallurgy Production & Maintenance Problems (813)
Open Hearth Practice (810)
Open Hearth Practice—Advanced (816)
Open Hearth Production & Maintenance Problems (826)
Physical Metallurgy I—Advanced (814)
Physical Metallurgy II—Advanced (815)
Protective Coatings on Metals (821)
Pyrometry (809)

RELATED ENGINEERING SCIENCES

902—Engineering Physics

Experience for admission: High school graduation with courses in algebra and trigonometry, or Course 914 (Engineering Mathematics), or equivalent experience in industrial computation.

Purpose: To train war workers in the fundamental concepts of mechanics, electricity, sound, heat and light enabling them to understand and logically explain the many industrial applications of these principles; to present an explanation of physical phenomena enabling trainees to readily and intelligently attack, solve, and master new industrial situations.

Description: The course includes discussions and demonstrations planned to cover practical aspects of mechanics, heat, light, sound and electricity. Most of the time is spent on mechanics and electricity with particular emphasis upon problems encountered by the worker in his daily routine. The laws of simple machines, conditions of equilibrium, linear and angular motion, stress-strain relationships are but a few of the topics covered in mechanics. In electricity the principal topics discussed are Ohm's law, and the thermal, mechanical, and chemical effects of an electric current.

903—Applied X-Rays

Experience for admission: An understanding of engineering physics, Course 902 or equivalent, or practical experience with X-ray equipment.

Purpose: To give workers engaged in, or planning to engage in, X-ray testing, a comprehensive survey of X-ray principles and applications; to train metallurgists and others to apply this important method of non-destructive testing to war materials.

Description: This course includes a study of atomic structure; nature of X-rays; use of X-rays in radiography; use of X-rays in structure analysis; construction, care, and operation of X-ray equipment, and interpretation of X-ray radiographic and diffraction pictures.

905—Applied Spectroscopy

Experience for admission: Applicants must have a working knowledge of high school physics, or Course 902 (Engineering Physics) or equivalent, or corresponding industrial experience.

Purpose: To train men and women of industry in methods and applications of spectroscopic chemical analysis; to discuss the theory and operation of spectroscopic instruments; to present guiding experiments to familiarize trainees with chemical analysis by the spectroscopic method.

Description: The course includes lectures and demonstrations covering principles of optics; theory of the origin of spectral emission; apparatus used in spectral

analysis; application of this type of analysis to routine study of alloy composition and impurity content; various methods of sample preparation, and methods of interpreting spectroscopic pictures.

907—Principles of Optics

Experience for admission: The applicant must be reasonably familiar with general physics of high school or college level, or Course 902 (Engineering Physics), or equivalent industrial experience.

Purpose: To train the war worker in present concepts of light, its behavior, and fundamental laws from which its behavior under various conditions can be predicted; to explain the construction and operation of many optical instruments used in industry.

Description: This course is mainly a topical discussion pertaining to the nature of light; laws of reflection from plane and curved surfaces; laws of refraction, interference and polarization; and the construction, care and use of optical instruments.

908—Engineering General Chemistry

Length of Course: Twelve weeks, two or three 3-hour periods a week for 72 or 108 hours, depending upon laboratory being a part of the course.

Experience for admission: High school graduation or the equivalent.

Purpose: To guide the war worker through a study of elementary chemistry by giving: an understanding of the language and terminology of chemists; detailed knowledge of the properties of matter in its various forms and of its behavior under various conditions; an acquaintance with principles and rules which aid in correlating and classifying chemical facts, and an appreciation of the scientific method of approach to the solution of problems.

Description: This course covers general principles of chemistry, including a study of elements and their simpler compounds. Demonstrations are used frequently to illustrate materials discussed. The laboratory gives an opportunity to handle common chemical substances and to gain skill in carrying out chemical operations on a small scale. The laboratory is optional, but should be included if facilities are available. Throughout the lecture and laboratory work industrial processes are emphasized.

910—Applied Engineering Mathematics for the Machine Industries

Experience for admission: Applicants must have had algebra and geometry in high school, or equivalent experience in machine industry.

Purpose: To give men and women who are engaged in or plan to work in the machine industries such mathematical training as is necessary for more efficient production of war materials.

Description: This course includes instruction in that part of algebra, geometry, and trigonometry applicable to those skills encountered in interchangeable manufacture, including drafting, machine operation, toolmaking and designing.

913—Applied Engineering Mathematics for Electrical Engineers

Length of Course: Sixteen weeks, two 3-hour periods per week—total 96 hours.

Experience for admission: High school algebra and physics, or equivalent experience.

Purpose: To provide basic training in engineering mathematics applied directly to electrical and radio engineering.

Description: Lectures and recitations provide a mathematical background adequate for solving common electrical and radio problems. Mathematics and electrical theory are integrated in this course to give the student real "on the job" practice.

914—Engineering Mathematics

Experience for admission: Knowledge of fundamentals of algebra and geometry, or equivalent experience.

Purpose: To train men and women from industry in the uses and methods of algebra, trigonometry, logarithms and elementary analytical geometry; to approach these particular subjects from the practical and industrial viewpoint so that the trainee will find immediate application in his present job; to aid the worker with wide practical experience in acquiring the mathematical background necessary for a more complete understanding of many operations he now carries out by "rule of thumb."

Description: This course includes algebra through quadratic equations; trigonometry through the solution of oblique triangles, logarithms and exponential functions, and elementary analytical geometry. All these topics are taught strictly from the industrial or engineering viewpoint.

Additional Courses

Acoustics of Sound Systems (917)
Advanced Mathematics for Modern Engineering (912)
Engineering Fundamentals for Under-Engineers in U. S. Signal Corps (904)
Engineering Organic Chemistry (906)
Foundations of Engineering: Math-Physics (901)
Industrial Analytical Chemistry (916)
Mathematical Analysis for Engineers (909)
Pre-Service Training in the Fundamentals of Engineering (911)

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